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(58) Field of search

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## (54) Pressure sensor utilising Hall-effect device

(57) In an absolute or differential pressure sensor, the position of diaphragm 16 is indicated by the relative positions of a magnet 23 and a Hall-effect device 27.

As described, the sensor is divided into a sensing chamber 11 and a circuit chamber 12 by partition 14. Sensing chamber 11 is divided into two by diaphragm 16 which carries, sealingly mounted through a central hole, magnet 23 in non-magnetic housing 24. The Hall effect device 27 is fixedly mounted in circuit chamber 12 along with circuit board 28 and associated components (not shown).

Heating element 29 may be used to maintain an approximately constant temperature in pressure chamber 11.

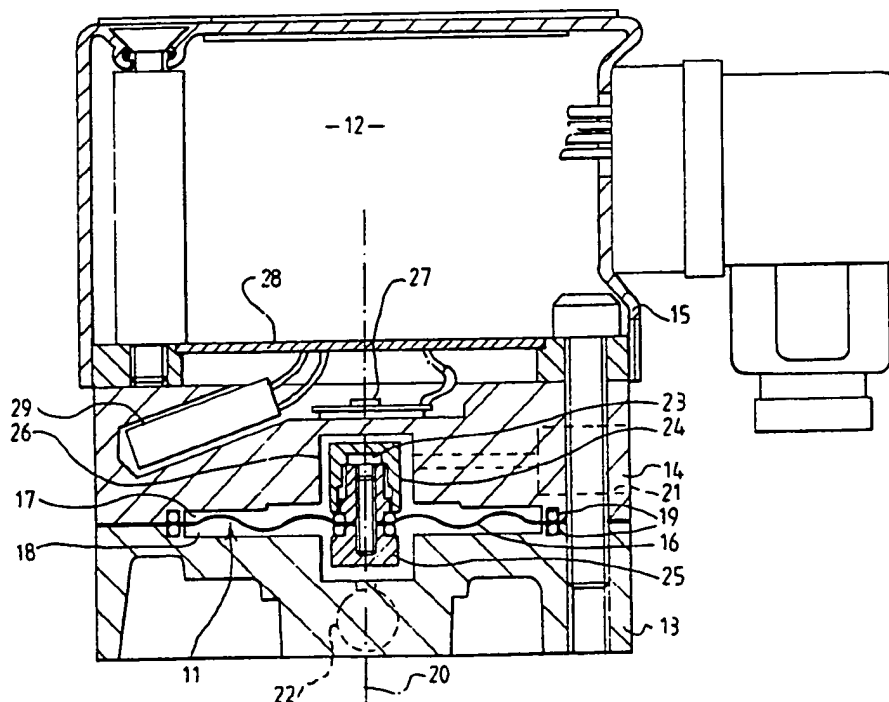


FIG 1

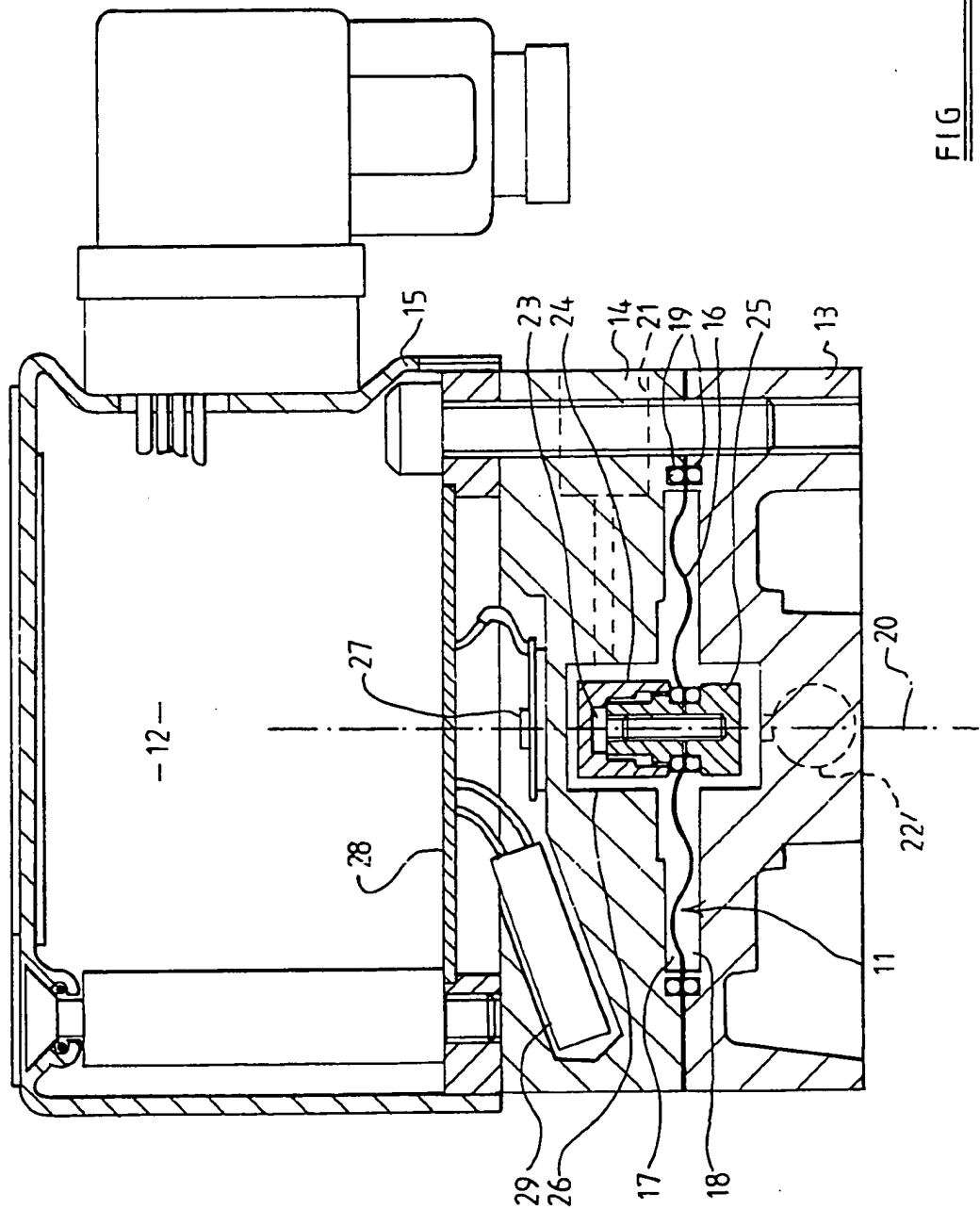


FIG 1

Title: Pressure-responsive device and method of indicating relation between pressures

Description of Invention

From one aspect, the present invention relates to a device comprising a hollow housing, a spring diaphragm inside the housing, an inlet port for admitting fluid under pressure to the housing to exert pressure on the diaphragm and signalling means for providing an electrical signal representing pressure in the housing exerted on the diaphragm. The signal may represent the absolute pressure in the housing or may represent the difference between the pressure at one side of the diaphragm and the pressure at an opposite side of the diaphragm.

According to the present invention, the signalling means of a device of the kind described includes a permanent magnet and a Hall-effect device, one of the magnet and the Hall-effect device being connected mechanically with the diaphragm to be moved thereby relative to the other of the magnet and the Hall-effect device.

The housing may include a partition which divides the interior of the housing into a pressure chamber and circuit chamber, the diaphragm being in or forming a boundary of the pressure chamber and the Hall-effect device being mounted in the circuit chamber. With this arrangement, it is unnecessary for any part or parts which is or are movable with the diaphragm to extend through the partition. Accordingly, it is unnecessary to provide at any opening through the partition seals which prevent escape of fluid from the pressure chamber to the circuit chamber.

It would also be within the scope of the invention to mount the Hall-effect device on the diaphragm or otherwise connect the Hall-effect device mechanically with the diaphragm and mount the permanent magnet in a fixed position with respect to the housing.

According to a further aspect of the invention, a method of providing an indication of the relation between pressures at opposite sides of a diaphragm includes the steps of mounting a permanent magnet in a fixed position with respect to a central portion of the diaphragm, mounting a Hall-effect device in a fixed position with respect to a periphery of the diaphragm, so that the Hall-effect device is subjected to the magnetic field associated with the magnet, and processing an output signal provided by the Hall-effect device, the output signal varying when the diaphragm is deflected by a change in said relation between the pressures at opposite sides of the diaphragm.

An example of a device embodying the first aspect of the invention and which is used in a method according to the second aspect of the invention will now be described, with reference to the accompanying drawing, wherein there is shown a diagrammatic representation of a cross section through the device.

The device shown in the drawing comprises a hollow housing which is preferably formed entirely of non-magnetic materials. Within the housing there is defined a pressure chamber 11 and a circuit chamber 12. The housing preferably comprises at least three separately formed components, namely a base 13, a partition 14 and a cover 15. The material or materials of which the base and the partition are formed are preferably also selected to provide resistance to corrosion or other deterioration during use and to resist high pressures within the interior of the housing. The partition divides the pressure chamber 11 from the circuit chamber 12 and is interposed between the base and the cover. These components may be secured together by screws or in any other convenient way.

A spring diaphragm 16 is mounted in the housing. The diaphragm is conveniently trapped between the base 13 and the partition 14 and spans the pressure chamber 11, dividing that chamber into upper and lower sub-chambers 17 and 18. In the example illustrated, the diaphragm is circular and the housing 10 is therefore conveniently of

cylindrical form. Adjacent to the periphery of the pressure chamber 11, seals 19 are interposed between the diaphragm and both the base 13 and partition 14 to prevent escape of fluid from the pressure chamber at the interfaces between the base, partition and the diaphragm. At least that portion of the partition 14 which lies between the seals 19 and a longitudinal axis 20 of the housing is imperforate.

There is formed in the partition 14 a first inlet portion 21 for admitting fluid under pressure to the upper sub-chamber 17. A second inlet port 22 is formed in the base 13 for admitting fluid to the lower sub-chamber 18.

A permanent magnet 23 is mounted in a fixed position with respect to a central portion of the diaphragm 16. In the example illustrated, the magnet is contained in a non-magnetic housing 24 which is secured to the diaphragm by a screw 25 having a shank which extends through a central aperture formed in the diaphragm. This aperture is surrounded by seals interposed between the housing 24 and the head of the screw 25 to prevent leakage. As shown in the drawing, the magnet 23 is offset from the diaphragm in a direction towards the circuit chamber 12. There is formed in the partition 14 a recess 26 having an open mouth which faces towards the diaphragm. A part of the magnet housing 24 which contains the magnet 23 is received in this recess but there is between the end of the recess and the housing 24 a clearance. There is no mechanical interference between the magnet housing 24 and the housing 10 of the device.

A Hall-effect device 27 is mounted in the circuit chamber 12 in a position where it will be subjected to the magnetic field associated with the magnet 23. As shown in the drawing, the Hall-effect device is positioned at the axis 20 on a surface of the partition 14 which faces towards the circuit chamber and adjacent to the recess 26. The magnetic poles of the magnet 23 face along the axis 20. There is also disposed in the circuit chamber 12 a circuit board 28 bearing components (not shown) of an electrical circuit which is capable of energising the Hall-effect device

27 and capable of processing the output of that device to provide an amplified electrical output signal. This output signal may be applied to an extraneous indicator or control device. The electrical circuit may be arranged to provide an electrical output signal which varies in a linear manner with the difference in pressure between the sub-chambers 17 and 18.

The electrical circuit may also include a heating element 29 for supplying heat to the partition 14 and the base 13 for maintaining at least an approximately constant temperature within the pressure chamber 11.

When the device is to be used to provide an indication of the differential pressure across the diaphragm, the two sources of pressure concerned are connected to respective ones of the ports 21 and 22. The movement of the central portion of the diaphragm is influenced only by the inherent stiffness of the diaphragm and by the pressures in the sub-chambers 17 and 18. It will be noted that there is no mechanical interference with movement of the central portion of the diaphragm. As the diaphragm moves in response to the changes in the differential pressure, the density of the magnetic flux to which the Hall-effect device 27 is subjected varies and the output from this device varies accordingly.

The device may alternatively be arranged for providing a signal representing the absolute value of pressure in a fluid. In this case, one of the sub-chambers 17 and 18 is hermetically sealed and evacuated and the fluid is admitted to the other sub-chamber alone.

The device illustrated in the drawing may also be modified by mounting the magnet 23 in the pressure chamber 11 and mounting the Hall-effect device in the housing 24. With this arrangement, it is necessary to provide electrical conductors which extend from the housing 24 to other components of the electrical circuit and to ensure that these conductors do not interfere mechanically with movement of the central portion of the diaphragm.

Further signalling means may be provided at that side of the base which is remote from the diaphragm, the further signalling means

comprising a Hall-effect device which responds to the magnet 23 or to an additional magnet mounted on the diaphragm.

There is preferably selected a diaphragm 16 having a stiffness which corresponds to the differential pressures to be measured. Typically, the deflection of the diaphragm from a reference position occupied when the differential pressure is zero is in the region of one millimetre. The distance from the magnet 23 to the Hall-effect device 27 when the diaphragm is in the reference position is typically up to 6 millimetre. We have found that output signals which are reproducible within a tolerance limit of less than 1.5% can readily be achieved and a tolerance limit of one quarter of 1% is possible with the device illustrated in the drawing. Relatively small differential pressures can be measured accurately at high line pressures. Since there are no moving seals subjected to the pressure in either sub-chamber, the mechanical reliability of the device is much better than in known devices where mechanical movement is transmitted through an aperture in a wall of a pressure chamber.

The features disclosed in the foregoing description, or the accompanying drawings, expressed in their specific forms or in terms of a means for performing the disclosed function, or a method or process for attaining the disclosed result, as appropriate, may, separately or in any combination of such features, be utilised for realising the invention in diverse forms thereof.

## CLAIMS

1. A device comprising a hollow housing, a diaphragm inside the housing, an inlet port for admitting fluid under pressure to the housing to exert pressure on the diaphragm and signalling means for providing an electrical signal representing pressure in the housing exerted on the diaphragm, wherein the signalling means includes a permanent magnet and a Hall-effect device and wherein one of the magnet and the Hall-effect device is connected mechanically with the diaphragm to be moved thereby relative to the other of the permanent magnet and the Hall-effect device.
2. A device according to Claim 1 wherein the housing includes a partition which divides the interior of the housing into a pressure chamber and a circuit chamber, the diaphragm is in or forms a boundary of the pressure chamber and the Hall-effect device is mounted in the circuit chamber.
3. A device according to Claim 2 wherein no part or parts movable with the diaphragm extends or extend through the partition.
4. A device according to Claim 1 wherein the housing includes a partition which divides the interior of the housing into a pressure chamber and a circuit chamber, the partition defines a recess facing towards the diaphragm and said one of the Hall-effect device and the magnet lies in the recess.
5. A device according to any preceding claim wherein the diaphragm is mounted by its periphery in the housing and wherein flexing of the diaphragm is inhibited only by the inherent stiffness of the diaphragm and the pressure acting on opposite faces of the diaphragm.



6. A method of providing an indication of the relation between pressures at opposite sides of a diaphragm wherein a permanent magnet is mounted in a fixed position with respect to a central portion of the diaphragm, a Hall-effect device is mounted in a fixed position with respect to a periphery of the diaphragm, so that the Hall-effect device is subjected to the magnetic field associated with the magnet and wherein the Hall-effect device provides an electrical output signal which is processed to provide said indication, the output signal varying when the diaphragm is deflected by a change in said relation.

7. A device substantially as hereindescribed with reference to and as shown in the accompanying drawing.

8. Any novel feature or novel combination of features disclosed herein or in the accompanying drawing.